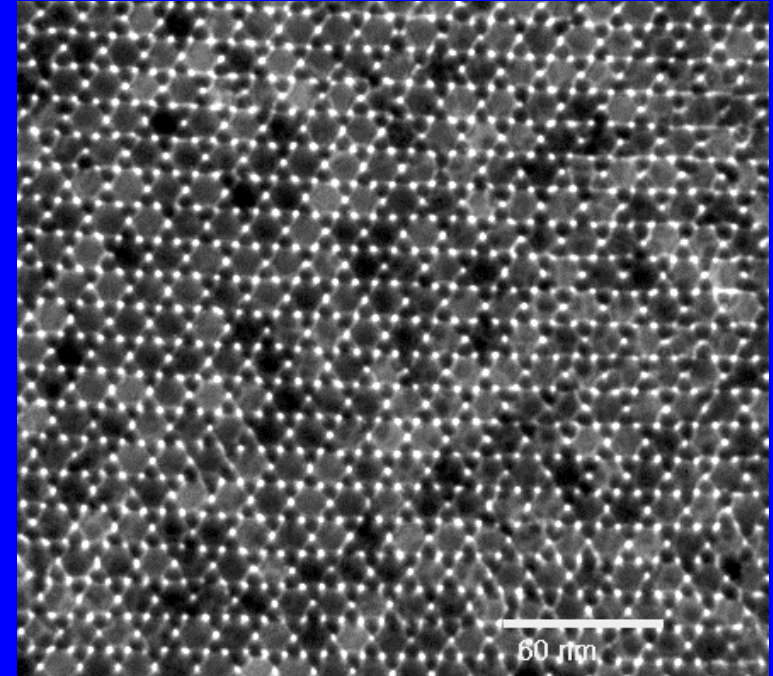


Nanocrystals: The Building Blocks of Nanoscience

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The ability to manipulate matter at the nanometer length scale has become a powerful driving force in the global scientific community. Concepts such as self-assembly are based on the ability to exert chemical control to levels of precision familiar to advanced engineering technology and suggest an increasingly important role for chemistry to play in the rational design of materials. Nanocrystals are isolated three dimensional nanometer scale units of materials, a well formed crystalline core. Due to the range of electronic, magnetic and optical properties possible, nanocrystal science provides many exciting avenues for young aspiring scientists to pursue.



A transmission electron micrograph of self-assembled superlattice of superparamagnetic Fe_2O_3 and FePt_3 Nanocrystals.

Nanocrystals can be used as building blocks to form simple ordered arrays, or superlattices, which resemble the close-packed structures of atoms in crystals. Using self-assembly, it is possible to form bimodal superlattices of nanocrystals based on a known intermetallic alloy structures.

The TEM is an image of a self-assembled 3D superlattice of nanocrystals. It is a binary assembly, composed of two different types of nanocrystals of different sizes: 13.4nm diameter gamma-Fe₂O₃ (maghemite) and 6.2 nm diameter CoPt₃. The particles are prepared by decomposition of the appropriate metal precursors in hot organic solvents. They have a uniform, single phase, crystalline core and are capped with a surface ligand (inherent to the synthesis). The ligand passivates the surface and renders the particles stable with respect to aggregation. The ligand surface is also hydrophobic and allows the particles to be dispersed in non-polar solvents, such as hexane. These two sets of particles were mixed together and the solvents allowed to evaporate very slowly in order to form the self-assembled superlattice. The superlattice mimics the AB₂ structure, a known structure that can form under the appropriate thermodynamic conditions, for hard spheres of diameters in the ratio of about 0.5-0.6. The work is a recent result that is a continuation of research performed in my group, in conjunction with Columbia MRSEC and the IBM TJ Watson Research Center. Please see a former NSF press release for more background on the formation of nanocrystal superlattices:

<http://www.nsf.gov/od/lpa/news/03/pr0368.htm>